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09/603,147	06/23/2000	John T. Moore	MI22-1443	3541

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EXAMINER	
KIELIN, ERIK J	
ART UNIT	**PAPER NUMBER**
2813	

DATE MAILED: 03/03/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

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Office Action Summary	Application No.	Applicant(s)	
	09/603,147	MOORE ET AL.	
	Examiner	Art Unit	
	Erik Kielin	2813	

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *16 January 2004*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *76,81,97 and 98* is/are pending in the application.

4a) Of the above claim(s) *none* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *76,81,97 and 98* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1)☐ Notice of References Cited (PTO-892)

2)☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3)☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date 1/16/04.

4)☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5)☐ Notice of Informal Patent Application (PTO-152)

6)☐ Other: _____.

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6)☒ Claim(s) *76,81,97 and 98* is/are rejected.

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1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

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6) ☐ Other: _____.

DETAILED ACTION

This action responds to the Response filed 16 January 2004.

Claim Rejections - 35 USC § 112

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. Claims 76, 81, 97, and 98 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

The instant specification fails to provide support for forming a layer "consisting essentially of a material having silicon, oxygen, and from about 2% to 20% carbon, by weight." Reasoning is as follows:

In the Response filed 16 January 2004, Applicant presents the argument,

> "Yau discloses utilization of oxidized organo-silane layers. Yau further discloses that the carbon content of such films can be from 1-50%, by weight (col. 4, ll. 54-59). Yau additionally indicates that the carbon is preferably included in an alkyl group such as methyl or ethyl (col. 4, 11. 41-44). **Nowhere does Yau indicate or suggest utilization of materials other than hydrogen-containing materials**." (Response filed 16 January 2004, p. 5, first full paragraph. Emphasis added.)

Accordingly, Applicant argues that Yau cannot produce a film "consisting essentially of a material having silicon, oxygen, and from about 2% to 20% carbon, by weight" because Yau is

using only hydrogen-containing precursor materials. Similarly however, **the instant specification states,**

> "The carbon can be introduced in the form of a carbon-containing deposition (CVD) of gas provided as a precursor during chemical vapor the material within which carbon is desired. Such carbon-containing gas can comprise, for example, one or more of **tetraethylorthosilicate** (TEOS), **bis-tertiary butyl aminolsilane** (BTBAS), **methane**, carbon dioxide, or carbon tetrachloride. In an exemplary application wherein carbon is incorporated into silicon nitride, the silicon nitride can be formed by chemical vapor deposition utilizing **dichlorosilane** and **ammonia**, at a temperature of from about 300 °C to about 750 °C and a pressure of from about 50 mTorr to about 2 Torr, and in the presence of an above-discussed carbon-containing gas." (Instant specification, paragraph bridging pages 13-14. Emphasis added.)

Each of the highlighted precursors contain **hydrogen**. As a matter of fact, the instant specification provides absolutely **no** precursor materials which contain silicon that are absent hydrogen. By Applicant's own arguments of record, then, the instant disclosure is not enabled because the instant specification has failed to provide a means for eliminating hydrogen in the film "consisting essentially of a material having silicon, oxygen, and from about 2% to 20% carbon, by weight" since all of the precursors used have hydrogen.

As further evidence, the instant specification states the following,

> "An etch stop layer 132 is formed over substrate 112 and over wordlines 120 and 122. In accordance with an aspect of the present invention etch stop layer 132 has carbon incorporated therein. Etch stop layer 132 can comprise, for example, silicon oxide or silicon nitride, and **can consist essentially of silicon, nitrogen and carbon, or can consist essential of silicon, oxygen and carbon.** For purposes of the discussion that follows, etch stop layer 132 will be referred to as a silicon nitride layer. Portions 115 of nitride layer 132 extend along sidewall spacers 128 and 130. Silicon nitride layer 132 can be formed to a thickness of less than or equal to about 500â, and can be formed by, for example, chemical vapor deposition of silicon nitride in the presence of **BTBAS**. Specifically,

> silicon nitride layer 132 can be deposited in a chemical vapor deposition reactor having a pressure of from about 50 mTorr to about 10 Torr, a temperature of from about 575 C to about 750 C, a flow rate of **SiH_4** of from about 0 to about 500 sccm, a flow rate of **NH_3** of from about 0 to about 2000 sccm, 500 sccm, to form to about 20% carbon and a flow rate of **BTBAS** of from about 0 to about silicon nitride layer 132 having from about 2% incorporated (by weight)." (Instant specification, paragraph bridging pages 17-18. Emphasis added.)

Again, **only hydrogen-containing precursors are used** to form specifically a material "**consisting essentially of silicon, nitrogen, and carbon, or silicon, oxygen, and carbon**" but, as argued by Applicant in the response, **no** hydrogen, because hydrogen-containing precursors are used. Applicant clearly contradicts the instant specification by arguing that the Yau etch stop material cannot consist essentially of silicon, oxygen, and carbon, because hydrogen-containing precursors are used, when the instant specification points out a specific example which forms a material "consisting essentially of silicon, nitrogen, and carbon, or silicon, oxygen, and carbon" by using expressly **only hydrogen-containing precursors**. Accordingly, Applicant argues that his own specification fails the written description requirement for failing to provide a means form making the claimed material: a material "consisting essentially of silicon, oxygen, and from about 2% to about 20% carbon, by weight" because only hydrogen-containing precursors are used.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person

having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 76, 81, 97, and 98 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's admitted prior art (**AAPA**) in view of US 6,136,700 (**McAnally** et al.) and US 6,054,379 (**Yau** et al.).

Regarding independent claim 76, **AAPA** clearly discloses each of the features of the DRAM including a semiconductor substrate **12**, the three nodes **14, 16, 18** in gated electrical connection via wordlines **20, 22** with sidewalls **28, 30** (i.e. the wordlines are the conductive gates controlling the connection between the capacitors and the storage nodes); capacitor constructions **36, 38** formed in the openings of and directly against the insulating layer **34** --which may be BPSG as further limited by instant claim 98-- and directly against the substrate **12**; bit line contact **46**; the etch stop **32** formed over, along, and proximate the wordlines and extending along and against a portion of the storage node (first electrode **40**). Each capacitor construction comprises a storage node (first electrode) **40** formed of conductively doped polysilicon (specification, p. 4, lines 16-18), dielectric **42**, and second electrode **44**. (See Prior Art Figures 1-4 and specification, section entitled, Background of Invention" -- especially pp. 5-8. Compare especially **AAPA** prior art Fig. 1 with non-prior art Fig. 7.)

The **AAPA** is silent to (1) the sidewall spacer material consisting essentially of a material having carbon, silicon, and oxygen and (2) the insulating layer being in contact with at least one of the carbon-containing sidewall spacers.

Regarding (1), **McAnally** teaches forming either or both the sidewall spacers **108** and etch stop **110** from the aforementioned composition containing carbon, silicon, and oxygen and can comprise silicon carbide --as further limited by instant claim 81-- to improve etch selectivity

specifically for etching a storage node contact. Regarding (2) **McAnally** teaches that the etch stop layer **110** may be omitted because the sidewall spacers are made of the etch-resistant carbon-containing material and that this beneficially eliminates an etch step. (See Abstract; col. 3, lines 37-40; claim 3; col. 5, lines 10-43; col. 6, lines 25-31.)

It would have been obvious to one of ordinary skill at the time of the invention was made to use the sidewall spacer material of **McAnally** for the sidewall spacer material of **AAPA** for the reasons indicated in **McAnally** --especially to protect to the gate structure from being damaged during etching of the opening for the storage node contact. It would be obvious to have the insulative material **34** of **AAPA** directly contacting one of the sidewall spacers (i.e. omitting the etch stop layer **32**) to beneficially reduce the number of etch steps, as taught to be beneficial in **McAnally**.

Then the only difference is that neither **AAPA** nor **McAnally** indicates the amount of carbon in the sidewall spacers to be "from about 2% to about 20% carbon."

Yau teaches an etch stop material containing silicon, oxygen and from 1% to 50% carbon with 20% being preferred, which reads on "from about 2% to about 20% carbon" (Abstract, col. 4, lines 18-63). The etch stop material provides good selectivity relative to non-carbon containing dielectric materials such as silicon dioxide or doped silicon oxide (col. 12, lines 1-38; Figs. 8A to 8F).

It would have been obvious to one of ordinary skill at the time of the invention to use the silicon, oxygen and 20% carbon content taught by **Yau** in the sidewall spacers of **AAPA** in view of **McAnally** because (1) **McAnally** suggests using a carbon-rich oxide as the etchstop/sidewall material and (2) **Yau** teaches a specific "carbon-rich oxide" containing silicon, oxygen, and

"preferably about 20%" carbon by weight, which also gives good etch selectivity between the etch stop and the same overlying insulating material in each of **AAPA**, **McAnally**, and **Yau**. Note that the overlying insulating material in each of **AAPA** (item 34 in prior art Fig. 1), **McAnally** (item 112 in Figs. 1C-1E) and Yau (items 510 and 518 in Figs. 8E-8F) is, *inter alia*, a silicon dioxide or doped silicon dioxide. (See instant application p. 4, lines 8-9; McAnally col. 3, lines 52-59; and Yau col. 12, lines 12-13.) Accordingly, a reasonable expectation of success exists for the use of the carbon-doped silicon oxide material in the **AAPA** structure, since each of **McAnally** and **Yau** teaches that the carbon-containing material is an etch stop relative to silicon oxide and doped silicon oxide. Moreover, **McAnally** teaches the carbon-doped silicon oxide material is used as an etch stop for exactly the same purpose as that disclosed in the instant specification: to provide protection to the gate electrodes during etching of the node contact in the silicon oxide interlayer dielectric. **McAnally** is silent to the quantity of carbon, such that one of ordinary skill would be especially motivated to apply the teaching of **Yau,** since **Yau** teaches the appropriate amount of carbon (about 20% by weight) to gain etch selectivity relative to the overlying silicon oxide.

Further in this regard, although the carbon quantity is not exactly as claimed by Applicant, overlapping ranges are *prima facie* obvious in the absence of unexpected results. (See MPEP 2144.05.) In this case, there exists no unexpected result. Rather the result indicated in the instant specification is exactly the same as in each of **McAnally** and **Yau**: etch selectivity is provided by adding carbon to the silicon dioxide etch stop and/or the sidewall spacers which enables protection of the gate electrode during etching of the node contact.

Regarding claim 97, **AAPA** and **McAnally** do not teach that the sidewall spacers have a thickness of less than about 500 Å. However, **McAnally** further indicates that a success of the invention is that "the invention allows for maximizing the area on the substrate that is in contact with a self-aligned contact" and that "the large contact area reduces the contact resistance and therefore increases the performance of the semiconductor device." (See col. 2, lines 18-27.) And more pertinently, **McAnally** states, "Thus the use of an appropriate material for stopping layer **110** may allow the use of thinner films for the insulating film **106** and *the sidewall [spacers]* **108**, which increases contact area and improves planarity." (See col. 4, lines 42-45; Italicized emphasis added.) **McAnally** explicitly suggests minimizing the width of the sidewall spacers **108** which directly affect the contact area. The greater etch selective materials enable narrower or thinner sidewall spacers and etch stops because, as indicated in **McAnally**, the etch selectivity is greater between the carbon-containing materials and the non-carbon-containing materials. Accordingly, it would have been obvious for one of ordinary skill in the art, at the time of the invention to choose a sidewall spacer width of less than 500 Å in order to increase the contact area in accord with the **McAnally** invention and to thereby provide greater contact area in the **AAPA** contact. (Compare this with the instant specification paragraphs bridging pages 14-15 and 22-23, which conveys virtually the same concept as McAnally.)

Furthermore, the selection of the sidewall spacer thickness is *prima facie* obvious because it is a matter of determining optimum process condition by routine experimentation with a single variable, i.e. the thickness of the sidewall spacers within the implicit suggestion of **McAnally** which indicates that carbon-containing sidewall spacers and etch stops are more etch

selective, which implicitly indicates that said materials can perform the same etch-prevention function with less of the material. (See MPEP 2144.05.)

Furthermore, as devices shrink, so do the dimensions of the features of each device according to Moore's Law. Accordingly, the choice of sidewall spacer thickness is merely a matter of routine optimization, as indicated above. Applicant has not recognized an advantage not already known in the art regarding the thickness of the spacers. In other words, one of ordinary skill would not continue to use sidewall spacers of a thickness used in a 1-μm rule, for devices in a 0.18-μm rule; instead, the size of all of the features, particularly the sidewall spacers, would be necessarily be scaled down.

It would have been obvious to one of ordinary skill at the time of the invention to choose the sidewall spacer thickness in the **AAPA** to be less than 500 Å, depending upon the size of the opening between the wordlines, in order to optimize the sidewalls relative to the device being formed, and for the reasons just indicated above.

Response to Arguments

5. Applicant's arguments filed 16 January 2004 have been fully considered but they are not persuasive.

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986).

Applicant further argues that Yau does not teach a material consisting essentially of carbon, oxygen and silicon. Examiner respectfully disagrees. The material is the oxidized organo silane. In this regard, Applicant argues that Yau is using precursor materials that have hydrogen, such that the resulting layer would somehow not consist essentially of carbon, oxygen and silicon. For this reason, **Applicant is arguing that his own invention is not enabled** because the instant specification very clearly uses only hydrogen-containing materials (instant specification, paragraph bridging pages 17-18). It is held, absent evidence to the contrary, that the instant material consisting essentially of carbon, oxygen and silicon will also have hydrogen, because Applicant indicates that hydrogen-containing precursors are used. Based upon Applicant's own reasoning, then the instant claims are not enabled, because Applicant argues that

Conclusion

6. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event,

however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 571-272-1693. The examiner can normally be reached on 9:00 - 19:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr. can be reached on 571-272-1702. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Erik Kielin

Erik Kielin
Primary Examiner
1 March 2004